

Particle Spectra of Identified Charged Hadrons from p-p Collisions at RHIC

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Brookhaven National Laboratory
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Physics Motivation

- Identified Charged Hadrons in p-p collisions:
 - Provide baseline study for Au-Au and d-Au interactions:
 - Lower multiplicity; hence, cleaner data sampling environment
 - Data useful for detailed study of Cronin effect
- Information about the evolution of the process:
 - Spectra and ratios provide insight into:
 - Particle formation at “freeze-out”; *e.g., mechanism of hadronization...*
- Fragmentation into hadrons may reflect progression of the collision process

Overview of RHIC



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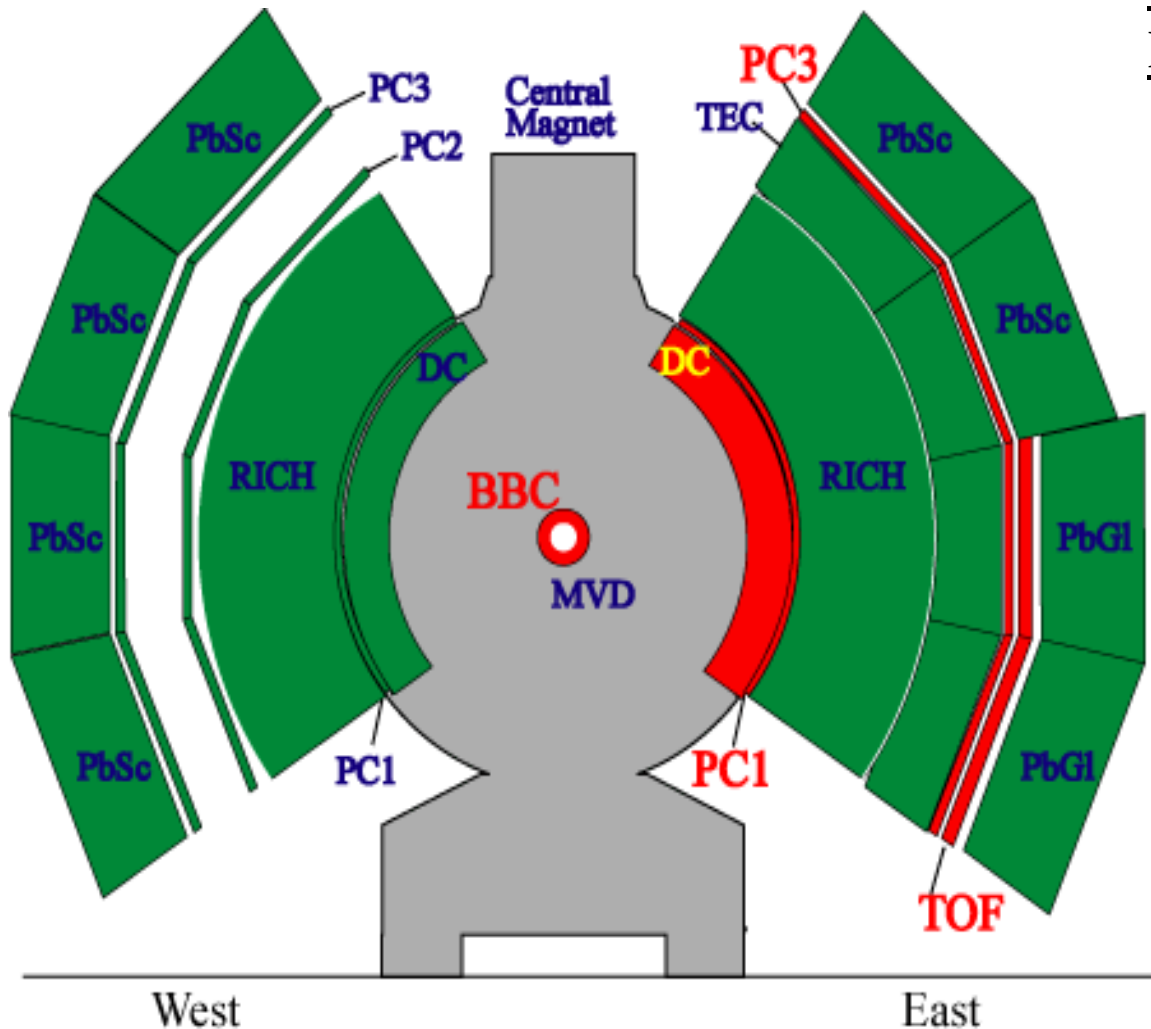
PHENIX Detector



Identified Charged Hadron Analysis

Detection Elements:

- **Beam-Beam Counter (BBC)**
 - ➔ Trigger, timing, and collision information
- **Drift Chamber (DC)**
 - ➔ Charge particle tracking and momentum information
- **Pad Chambers (PC1 -PC3)**
 - ➔ 3D space-point information on charged particles
- **Time-Of-Flight (TOF) Detector**
 - ➔ Timing information and charged hadron identification



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Particle Detection and Measurement

- Particle Identification (PID) is facilitated by:
 - High Resolution Time-of-Flight (TOF) detector
 - TOF time resolution: 120 ps, relative to 2σ cut in m^2 ; π , K separation up to 2 GeV/c; P/K separation extends up to $p_T = 4$ GeV/c - (Au-Au)
 - Beam-Beam Counter (BBC) provides *start clock* trigger

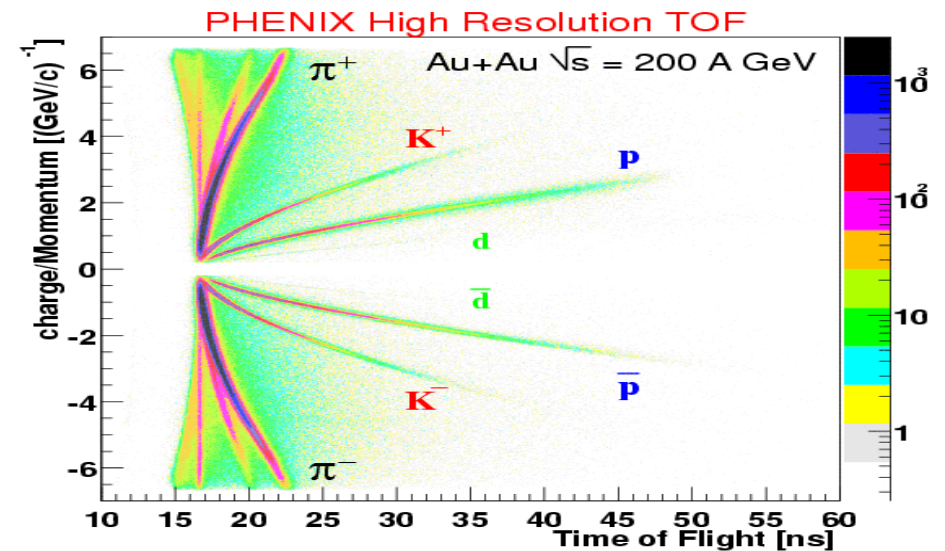
TOF



BBC

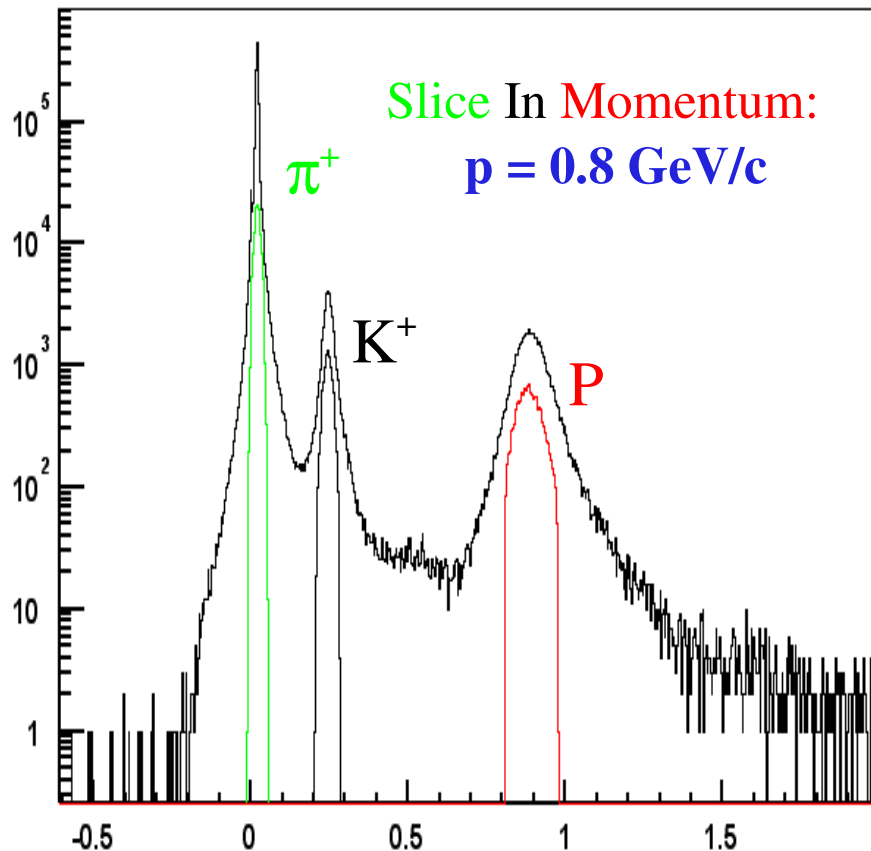


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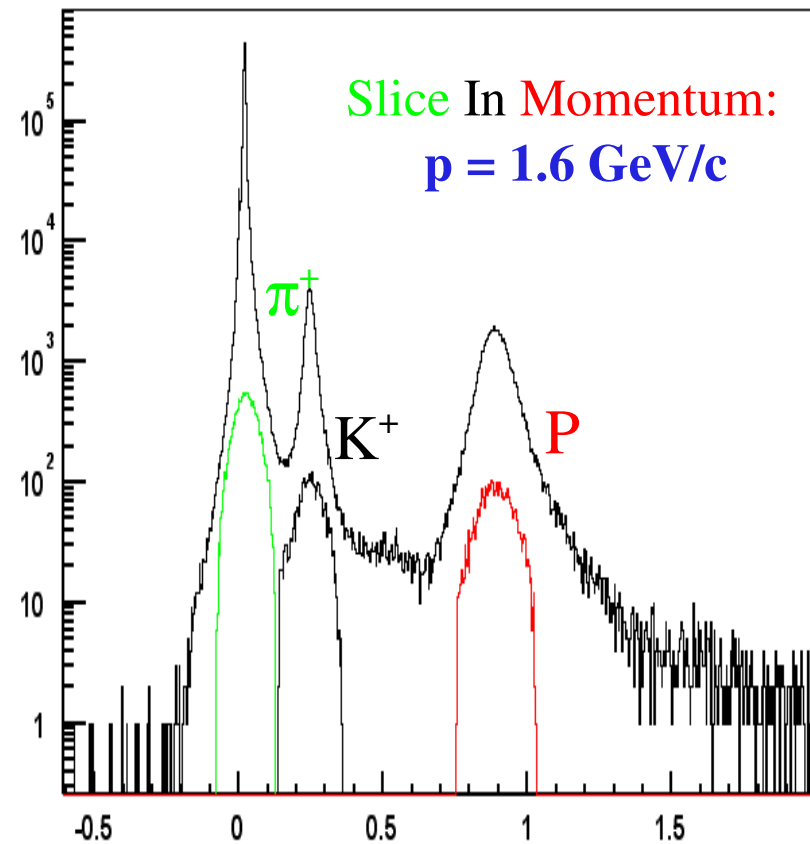


Mass Squared Distributions

Full m^2 distribution -- $(0.2 < p < 2.2)$ (GeV/c)

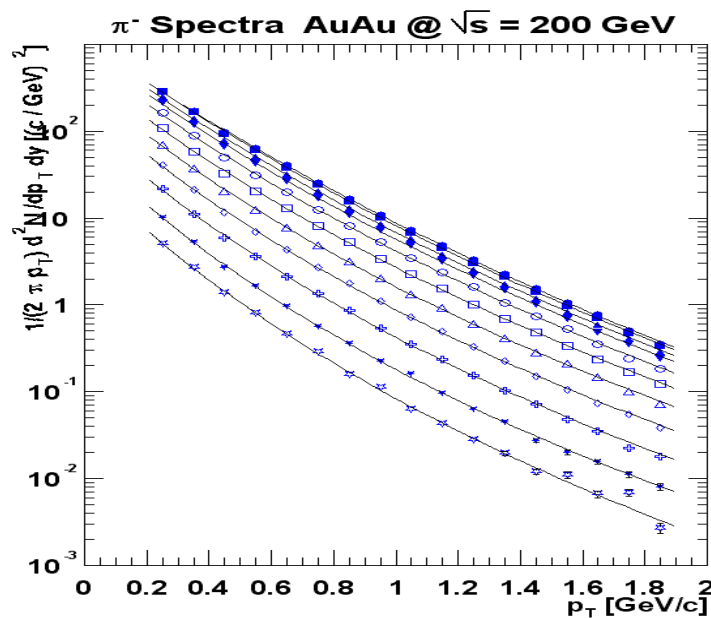
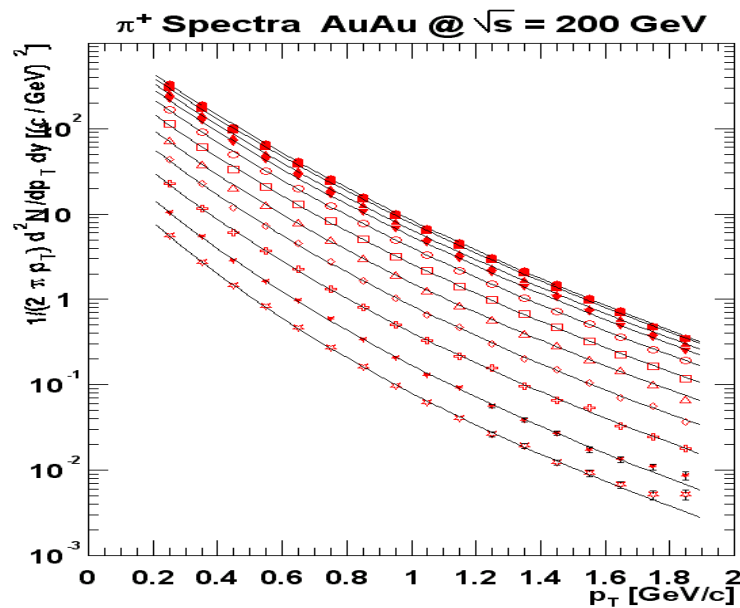


Full m^2 distribution -- $(0.2 < p < 2.2)$ (GeV/c)



In p-p, clean pion and kaon separation out to $|p| \sim 1.6$ GeV/c

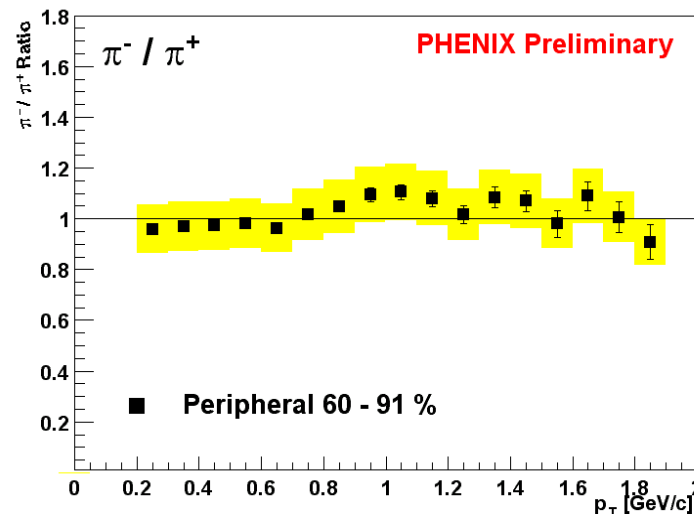
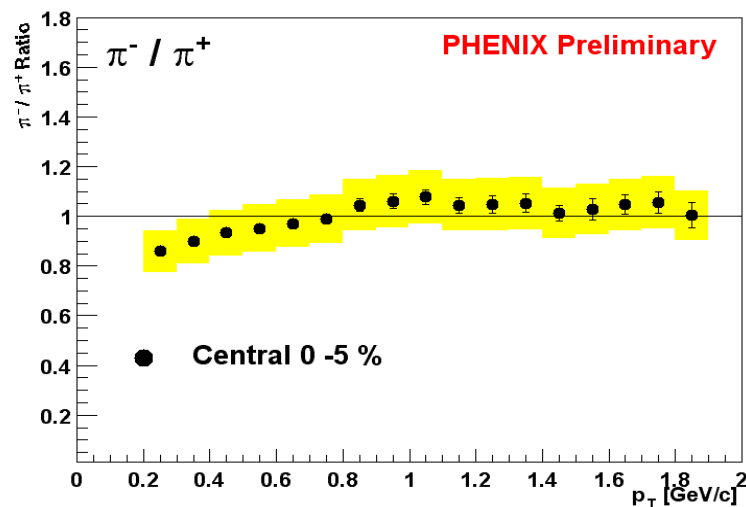
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Pion Au-Au Spectra and Ratios vs. p_T at $\sqrt{s} = 200$ GeV; Plots prepared by Tatsuya Chujo, BNL

Centrality

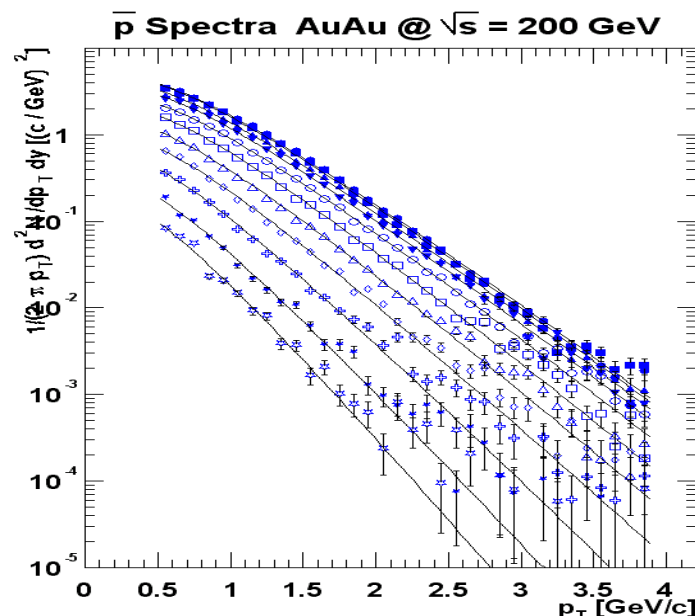
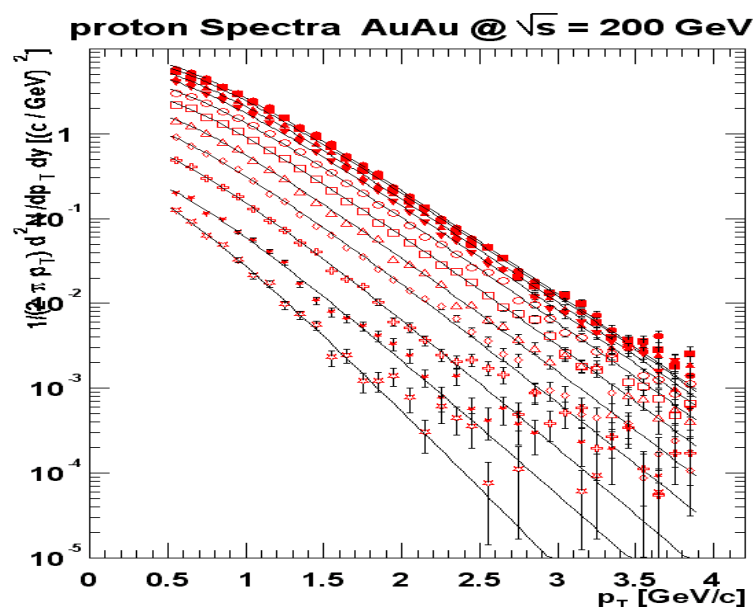
0 - 5 %
5 - 10 %
10 - 15 %
15 - 20 %
20 - 30 %
30 - 40 %
40 - 50 %
50 - 60 %
60 - 70 %
70 - 80 %
80 - 91 %



● Pion spectra,
“Characterized by
power law shape
shape for all
centralities”

● Pion ratios,
→ “flat p_T
dependence”
→ “no centrality
dependence”

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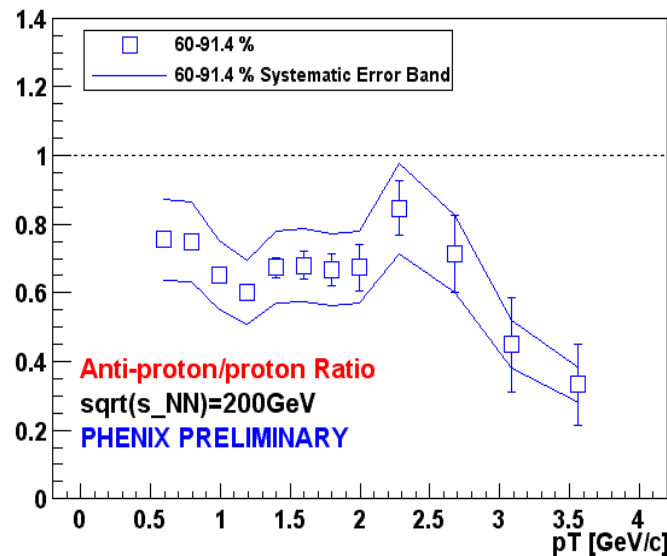
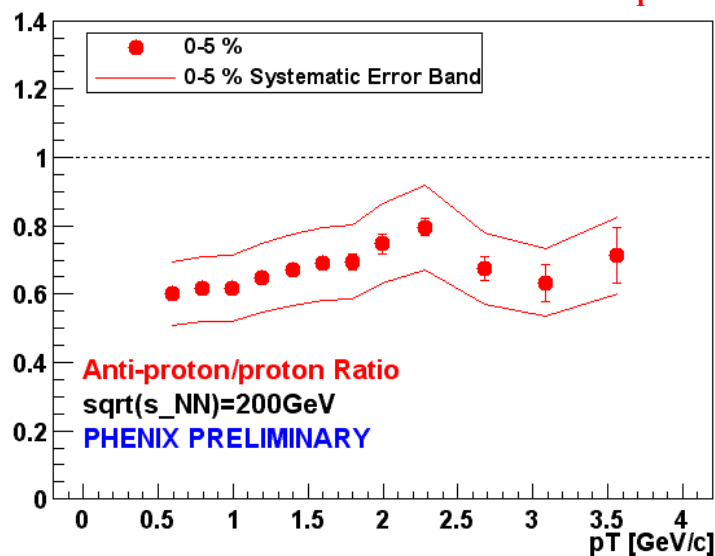


PHENIX

Centrality

0 - 5 %
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Proton Au-Au Spectra and Ratios vs. p_T at $\sqrt{s} = 200$ GeV; Plots prepared by Tasuya Chujo, BNL

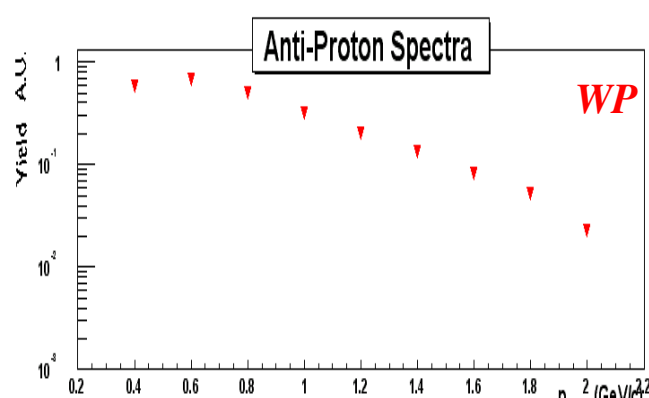
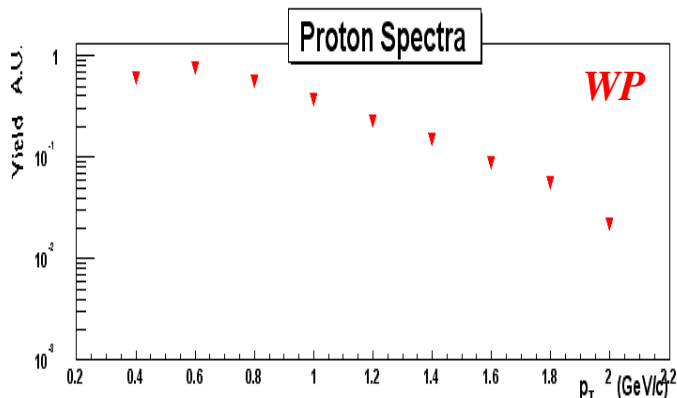
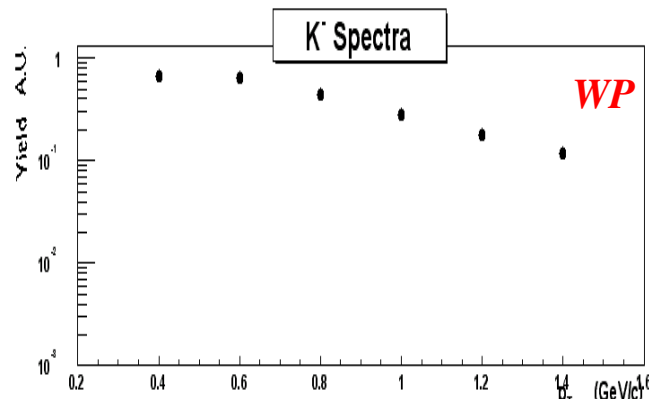
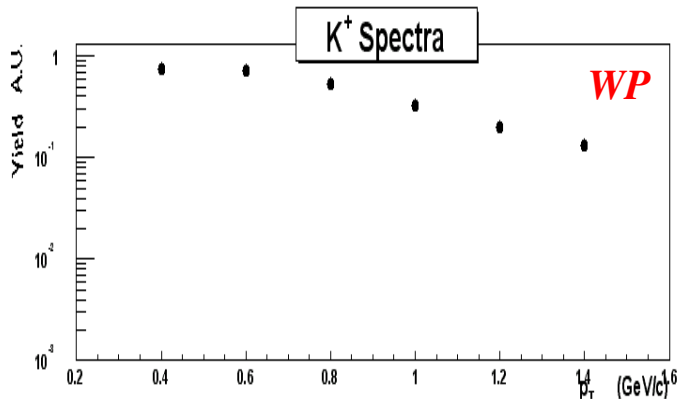
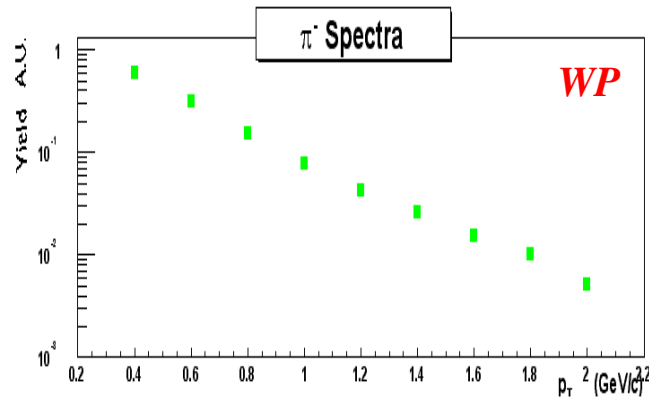
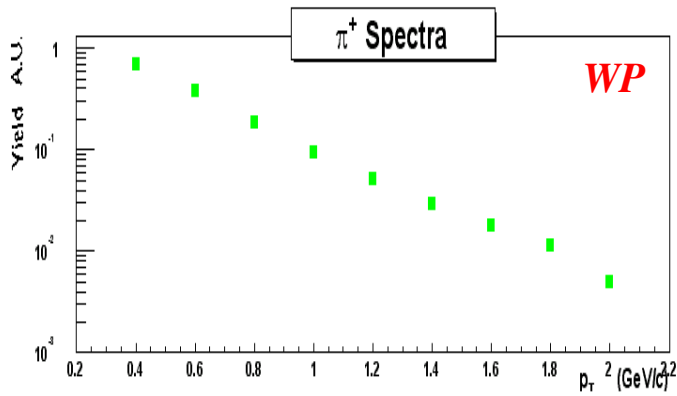


● Proton spectra,
“Characterized by
Boltzman shape for
all centralities”

● Proton ratios,
“central: flat p_T
dependence”
“possibly decreasing for
peripheral $> 3\text{GeV}$ ”

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Identified Charged Hadron Spectra vs. p_T at $\sqrt{s} = 200\text{GeV}$ in p-p collisions *Work in Progress (WP)*



- Pion spectra, may “depend upon power-law characterization”
- Kaon spectra, possible “indication of exponential fall off in p_T ”
- Proton spectra, perhaps “exhibits Boltzman-like shape”

Data analysis not fully mature enough to make any substantive statements at this point.

Identified Charge Hadron Spectra vs. p_T at $\sqrt{s} = 200\text{GeV}$ in p-p collisions

Work in Progress (WP)

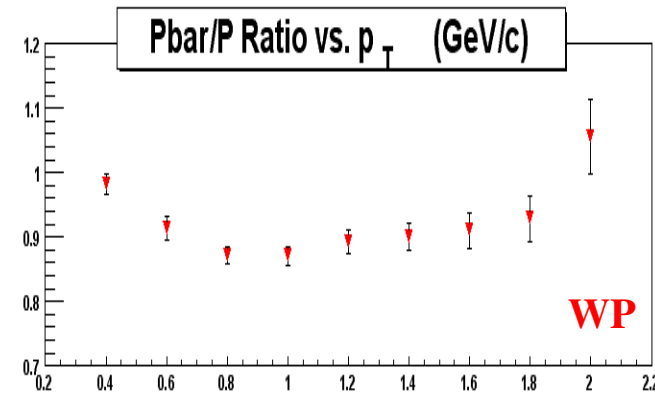
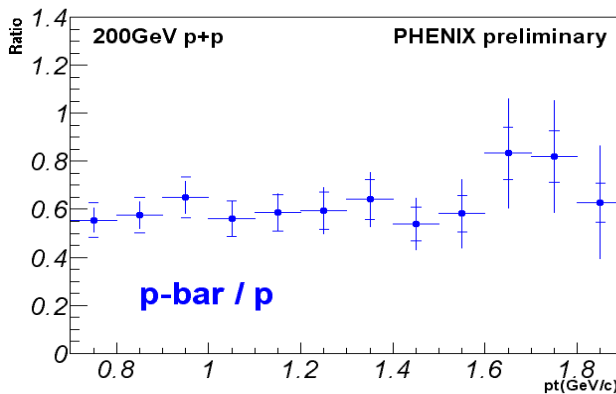
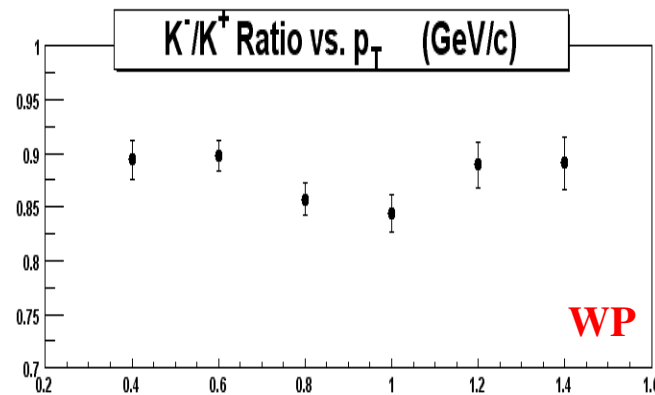
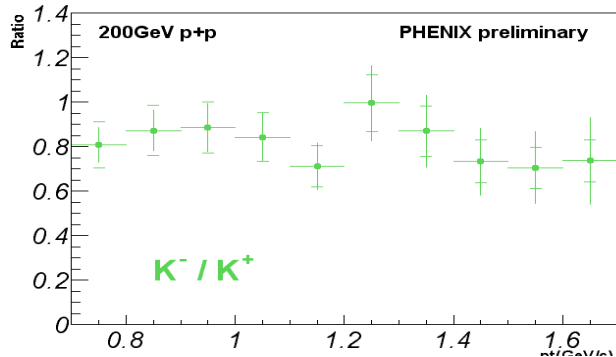
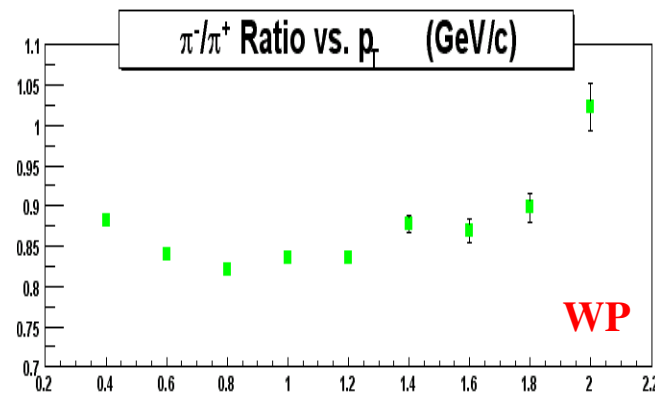
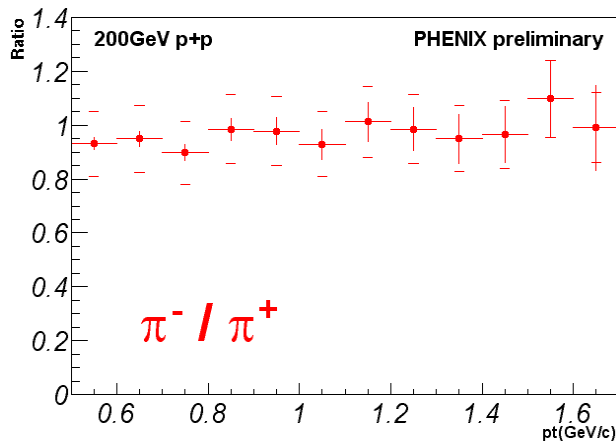
● Pion, Kaon, and

● Proton respective ratios:

- Uniformity within uncertainty (statistical only)
- No momentum dependence
- Range $\sim (0.2 < p_T < 2.0) \text{ GeV/c}$

● Comparison of ratios:

- Current π ratios appear to be fairly consistent with preliminary Au-Au and p-p results
- K ratios for p-p data analyses are also comparable
- Current Pbar/P ratio is inconsistent with preliminary Au-Au and p-p results
- Systematic study to commence in following weeks



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Summary

- **First p-p collision measurement at $\sqrt{s} = 200$ GeV**
- **The p-p analysis of the Identified Charge Hadron data set may serve as a good baseline tool**
 - **Provide baseline study for Au-Au and d-Au interactions**
 - **Important for study of Cronin effect at this CM energy**
- **Corrections to spectra:**
 - **Trigger efficiency**
 - **Sytematics**
- **Particle spectra and ratios – analyses are on going**